

Introduction

- Shrews (Soricidae) are an important part of forest food webs.
- They are extremely sensitive to microhabitat conditions such as temperature, moisture, and food availability.¹
- Timber harvest methods such as clearcutting can greatly alter microhabitat conditions.²
- Partial harvest techniques (e.g. shelterwoods) retain the overstory and may better preserve forest function.³
- Available literature on shrew responses to clearcuts and partial harvests is inconclusive.⁴



Figure 1.
Smoky shrew
(*Sorex fumeus*)

Objective

We compared shrew site occupancy among three forest management treatments: clearcut, partially harvested (shelterwood), and control (unharvested) forest.

Hypotheses

- Clearcutting will alter shrew microhabitat conditions; conditions will be similar in shelterwoods and controls.
- Reflecting these differences, shrew occupancy will be lower in clearcuts than the other treatments.

Methods

- Three study areas in southern IN (Figure 2)
- 76 sites subjected to varying harvest types trapped over a 4 yr period (2007-10)
- Each site trapped for 5 days with a combination of pitfall and Sherman live traps to create an encounter history for captured shrew species (n=3)
- Environmental covariates (e.g. aspect, canopy cover, insect biomass) measured for each site
- A hierarchical multi-species model of site occupancy with variable detection probability was fit in a Bayesian framework using R and WinBUGS
- Both occupancy and detection were allowed to covary with environmental variables

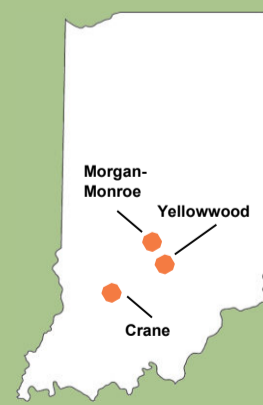


Figure 2.
Study locations

Results

- Over 4 years, 76 sites were sampled 1-4 times each to generate **163** encounter histories.
- There were **31,311** Sherman trap nights and **10,989** pitfall trap nights.
- In total, **187** short-tailed shrews (*Blarina brevicauda*), **24** smoky shrews (*S. fumeus*) and **21** southeastern shrews (*S. longirostris*) were captured

Variable	Type	N	Unit	Means			Test	p-value
				Control	Shelter	Clearcut		
Herb Cover	ordinal	144	-	2.562	2.312	3.833	K-W	<0.001
Woody Cover	ordinal	144	-	2.708	2.896	3.229	K-W	0.050
Canopy Cover	interval	144	%	93.15	92.56	17.42	ANOVA	<0.001
Woody Debris	interval	144	m	1.0167	0.8677	1.099	ANOVA	0.660
Litter Depth	interval	144	cm	4.542	3.688	0.771	ANOVA	<0.001
Insect Biomass	interval	128	g	1.988	1.253	1.013	ANOVA	0.081

Table 1.
Comparison of microsite data across harvest treatments. Significant differences are highlighted in orange.

- There were significant differences in environmental variables between harvest treatments
- Both herbaceous and woody understory cover was significantly higher in clearcuts than in the other treatments.
- Canopy cover was significantly lower in the clearcuts.
- Litter (e.g. leaves, organic matter) depth was also significantly lower in clearcuts.

Covariate	Short-tailed		Smoky		Southeastern	
	β	SE	β	SE	β	SE
p (detection covariates)						
JDC2	-0.73	0.16	-0.78	0.28	-0.84	0.26
Temperature	0.099	0.14	-0.24	0.26	0.013	0.18
Year08	-0.72	0.30	-0.90	0.58	-0.55	0.56
Year09	-0.46	0.43	-2.16	1.32	-2.12	1.30
Year10	-1.60	0.50	-0.41	0.71	0.64	0.62
Ψ (occupancy covariates)						
Aspect	0.84	0.47	1.11	1.46	1.22	1.43
Clearcut	-1.16	0.53	0.029	1.84	0.15	1.84
Shelterwood	-0.15	0.88	0.024	1.95	0.96	1.67

Table 2.
Parameter values from the hierarchical multi-species occupancy model. Significant parameters are highlighted.

- Detection for all species varied by Julian day squared centered around the mean (JDC2)
- Temperature did not affect detection probability, but there was a year effect for short-tailed shrews in 2008/2010 and for *Sorex spp.* in 2009.
- Short-tail shrew occupancy was significantly lower in clearcut sites and sites with a southwestern aspect.
- For all species, occupancy did not differ between shelterwood and control sites.

Results

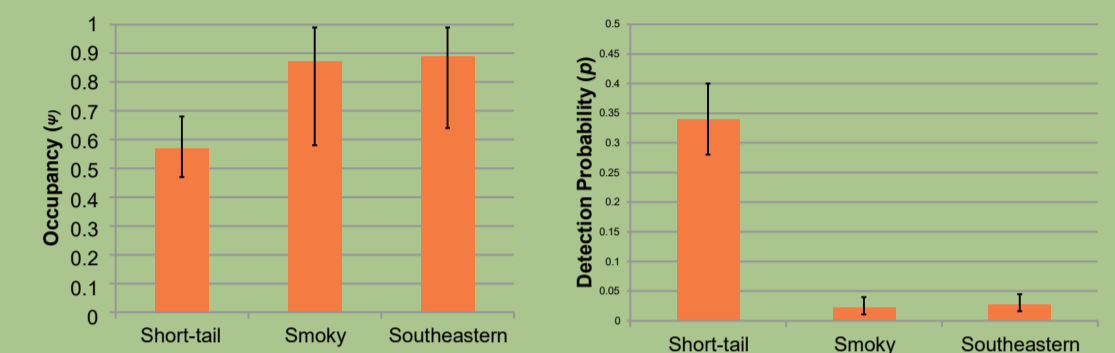


Figure 1.
Shrew site occupancy by species. Error bars represent 95% credible intervals.

Figure 2.
Detection probability by species. Error bars represent 95% credible intervals.

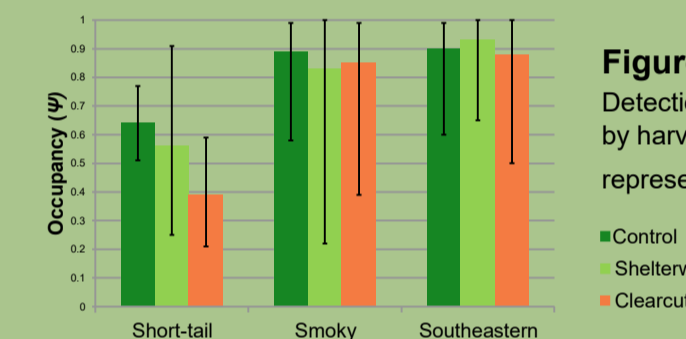


Figure 3.
Detection probability for each species by harvest treatment. Error bars represent 95% credible intervals.

Conclusions

- Microsite conditions related to shrew habitat differed by harvest treatment, supporting Hypothesis 1 (Table 1).
- Specifically, lower leaf litter depth (important for shrew movement) and insect biomass (shrew food source) may reduce habitat quality in clearcuts.
- Shelterwoods may better preserve microsite conditions important for shrews.
- Occupancy of short-tailed shrews was lower in clearcut sites, supporting Hypothesis 2 (Table 2, Figure 3).
- No occupancy covariate was significant for the *Sorex* species. Rapid growth of understory vegetation may provide suitable habitat in cut-over areas for *Sorex*⁴.
- Short-tailed shrew occupancy was also lower at sites with a southwestern aspect. Sites with a SW aspect are typically drier, and may be less suitable for use by shrews requiring high amounts of moisture¹.
- Overall, very low detection probabilities resulted in high estimates of occupancy for smoky and southeastern shrews (Figures 1 & 2). Difficulty detecting these species emphasizes the need for hierarchical models that account for imperfect detection.

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